COEST's TRACELAB: Infrastructure for Traceability Researchers and Practitioners

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Our roots…

- Seminal work in the mid 1990s highlighted the traceability problems faced in industrial practice

Beginnings of a community…

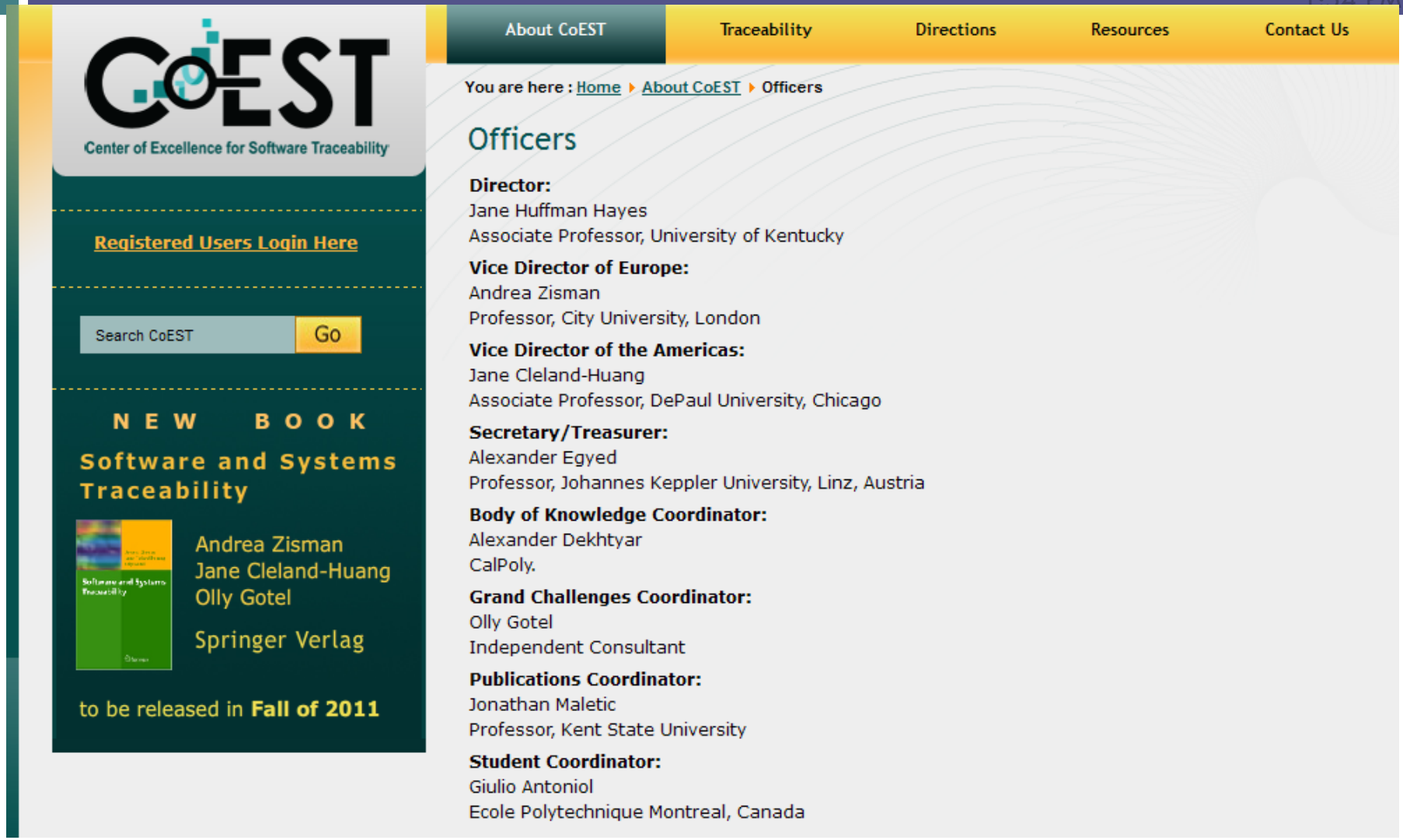
- George Spanoudakis and Andrea Zisman launched the TEFSE series of workshops to encourage research in this area
- TEFSE 2009, May 18, 2009, Vancouver, British Columbia, Canada
- TEFSE 2007, Also referred to as Grand Challenges of Traceability: GCT , Slade, Kentucky
- TEFSE 2005, November 8, 2005, Long Beach, CA
- TEFSE 2003, October 7, 2003, Montreal, Canada
- TEFSE 2002, September 28th, 2002, Edinburgh, U.K.

A forward looking idea…

- Idea: Form a **Center of Excellence for Software Traceability (COEST)**
- The first CoEST meeting occurred under the St. Louis Arch at ICSE 2005. It was attended by Jonathan Maletic, Guilio Antoniol, Alex Dekhtyar, Jane Cleland-Huang, Jane Hayes, and several students




COEST Organization



CoEST's vision

- The **vision** of the COE for Software Traceability is to provide leadership for traceability research, education, and practice; promoting the pursuit of excellence from research idea to practice, based on a foundation of innovative, ethical, collaborative work
- Seed funding was provided by NASA and NSF

Everyone welcome to

CoEST's vision will be achieved by:

- Identifying the **grand challenges** of traceability
- Fostering international research **collaborations**
- Developing a repository of **benchmarks** for traceability research
- Delivering **tutorials** in the areas of requirements engineering and traceability
- Constructing a **Body of Knowledge** for traceability
- Cultivating **partnerships** with industry and academia
- Providing the **infrastructure** needed to support the above

Lessons from a wise cat

In *Alice in Wonderland,* Alice encounters the Cheshire Cat and asks for directions

The cat responds that it depends upon where she wishes to go

Alice says she doesn't know, whereupon the cat tells her that it doesn't matter which way she walks

Towards the Grand Challenges…

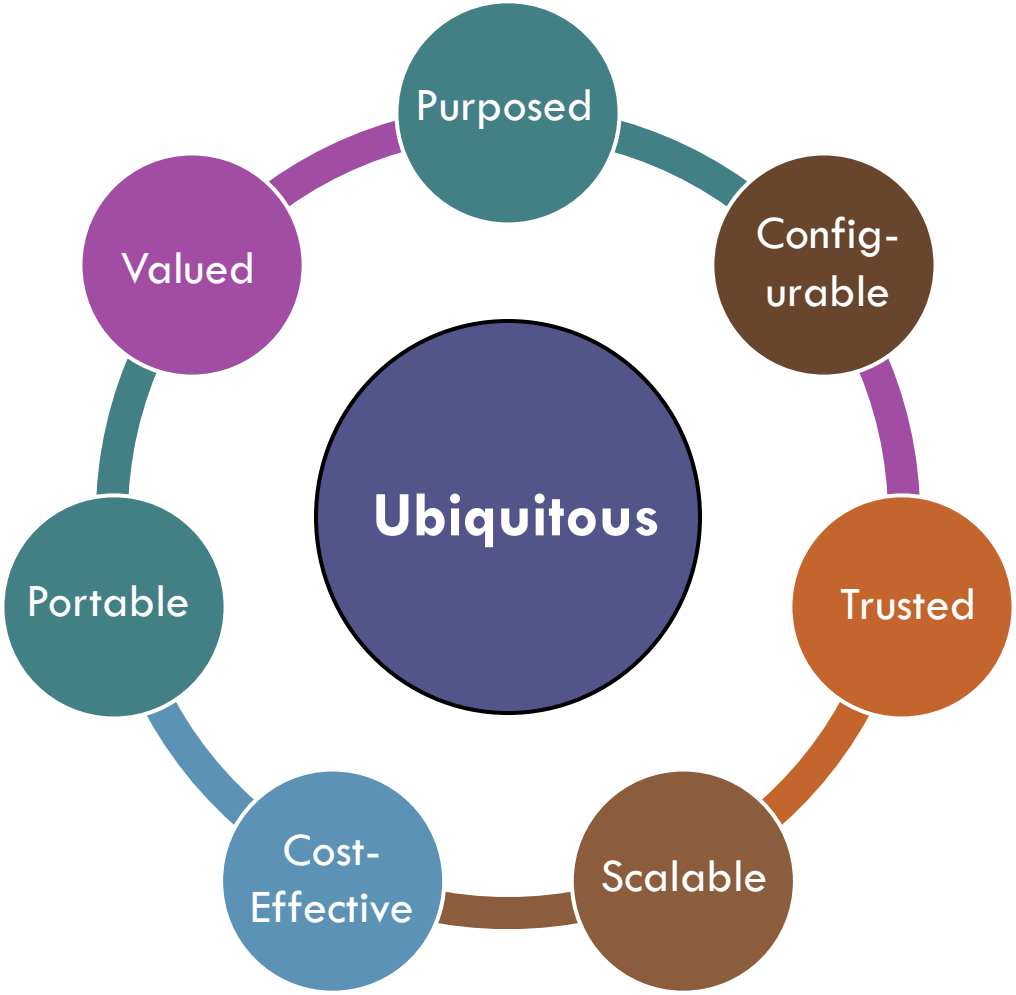
- A group of CoEST members met at NASA's IV&V facility in Fairmont, WV, to flesh out the grand challenges of traceability
- We produced GCT 1.0
- Over the past 2-3 years, a smaller group of people have been working to transform GCT 1.0 into a more cohesive research roadmap

The Traceability Grand Challenge

- Traceability is always there, without having to think about getting it there. Traceability is neither consciously established nor sought; it is built-in and effortless. It has effectively 'disappeared without a trace'
- Is our challenge **feasible**? Do practitioners agree that it is the **right** challenge?

The Goals of Traceability

Olly Gotel, Jane Cleland-Huang, Alex Dekhtyar, , Jane Huffman Hayes, Andrea Zisman,
Alex Egyed, Guilio Antoniol, Jonathan Maletic, Stephanie Ferguson, Ken McGill, Tim Menzies,
Marcus Fisher, Lisa Montgomery, Brian Berenbach, Paul Gruenbacher, & numerous PhD students….



For each Challenge

- Definition
- Description of desired outcome
- Problem addressed
- High level goals (3-4)
- Impact of challenge area on trace strategy, use, creation and maintenance
- Research Projects (1-2)
- Sub Research Projects (7-10)
- Industry Practice objectives (3-5)

GCT Summary

Challenges have been defined

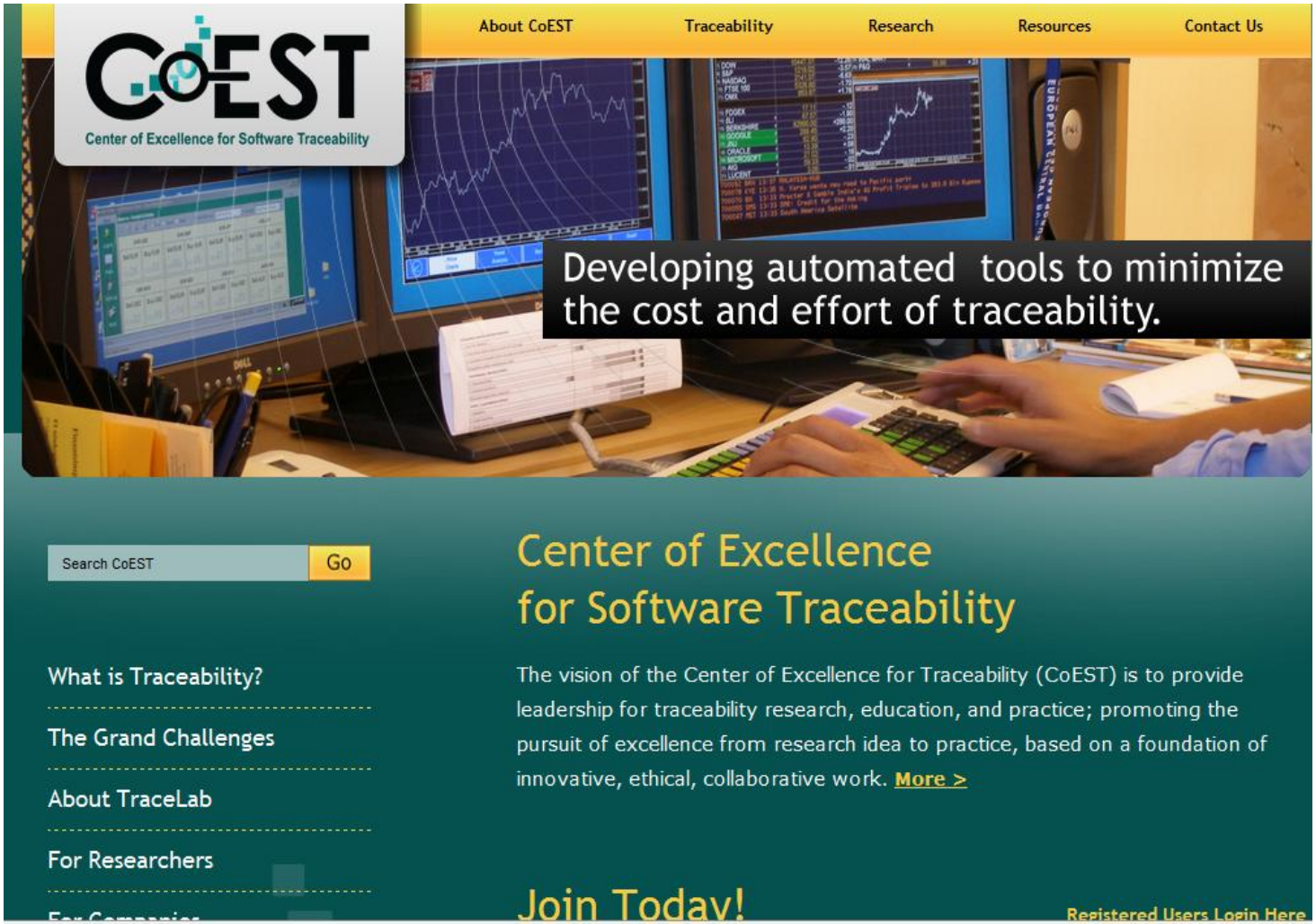
Early version of the challenges have gone live

- Each of the 8 challenge areas have been fully mapped to goals, research projects, and industrial adoption strategies
- Grand Challenges 2.0 are launched at http://www.CoEST.org
- Grand Challenges will serve as a **roadmap for guiding traceability research and advancing the state of practice**

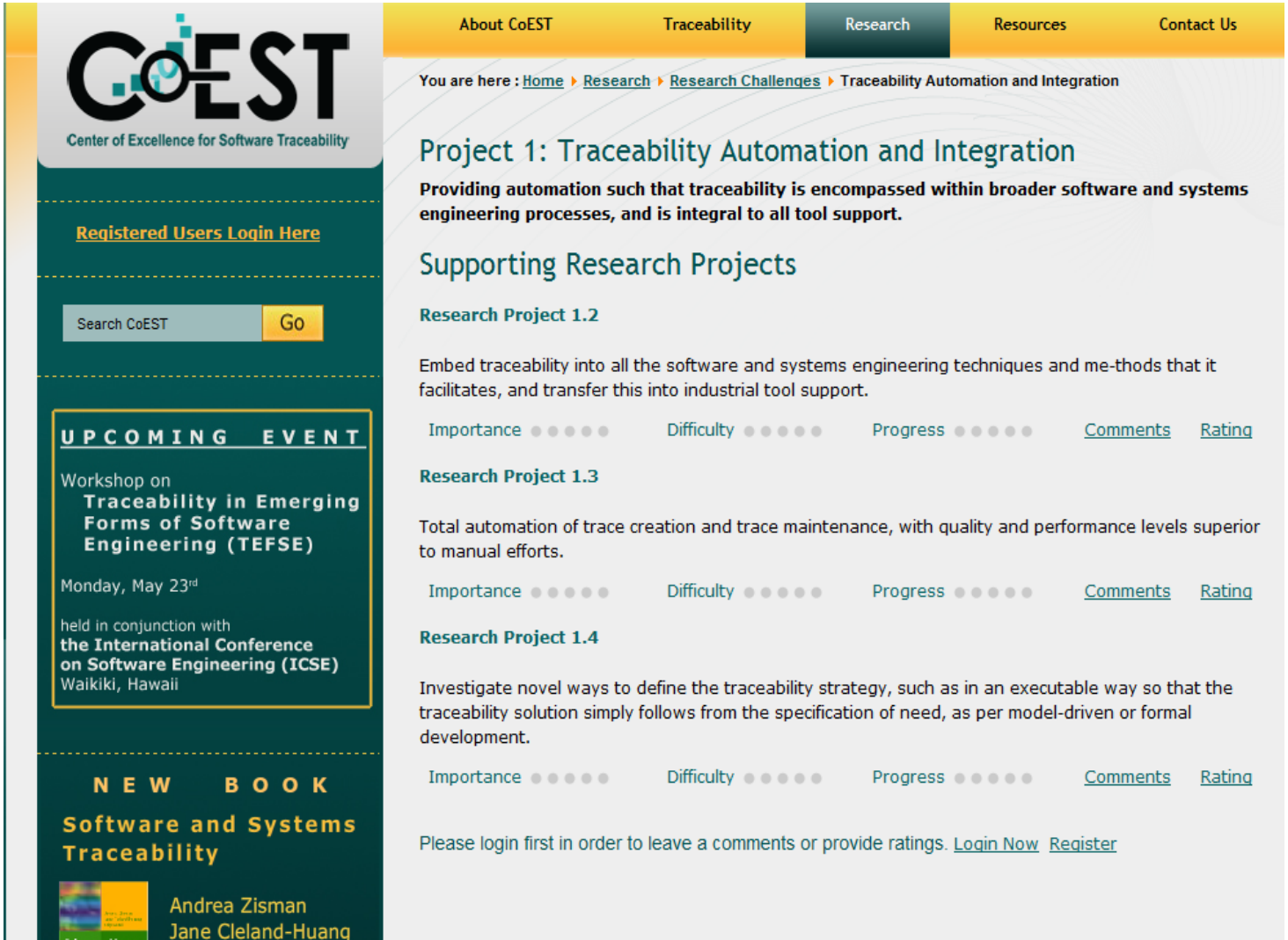
Ubiquitous Traceability

- **Major Research Project:** RP1.1 Provide automation such that traceability is encompassed within broader software and systems engineering processes, and is integral to all tool support
- **Supporting Research Projects:** RP1.2 Embed traceability into all the software and systems engineering techniques and methods that it facilitates, and transfer this into industrial tool support
- RP1.3 Total automation of trace creation and trace maintenance, with quality and performance levels superior to manual efforts

Tracking our progress…



Research Projects



How do we get there?

- So now we know where we want to go, but how do we actually get there?
- TEFSE (ongoing)
- CoEST
  - Grand Challenges
  - Benchmarking
  - TraceLab
  - Education and outreach

Equipping a community

Early work

TEFSE community

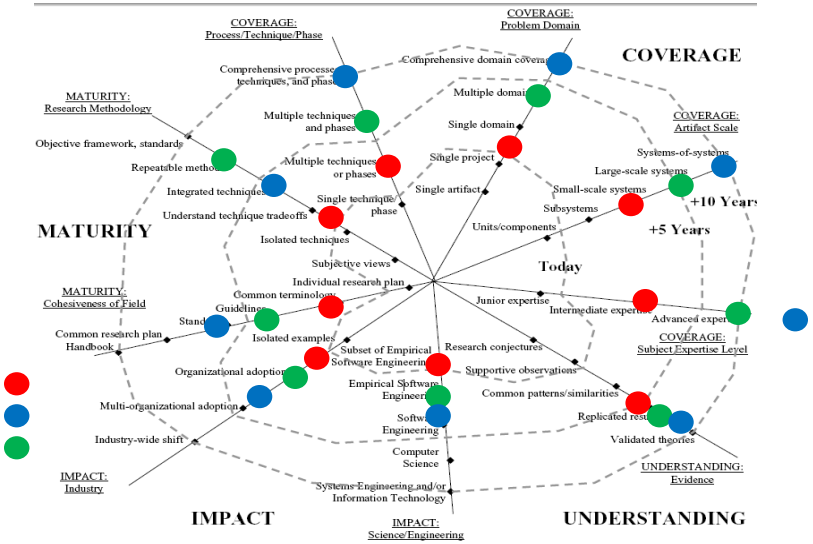
An idea

Towards a grand challenge

Beyond the challenges

MRI funding

- Establishing a research environment takes time and effort
- Comparing results and evaluating progress towards the traceability goals is difficult



Benchmarks

- A benchmark is a point of reference by which something can be measured
  - A program that is specially designed to provide measurements for a particular operating system or application
  - A set of performance criteria which a product is expected to meet
  - A set of conditions against which a product or system is measured

Benchmarks

- **Define a task**
  - Retrieve/Generate traces from high level to low level requirements
- **Provide datasets**
  - CM1, HIPAA to World Vista, IBS
- **Agree on a core set of metrics**
  - Recall, Precision, Lag, Average Precision (??)
- **Capture/Report benchmarked results**

What about Qualitative Studies?

- Several identified challenges are more qualitative in nature
- How do we comparatively evaluate processes and methods which don't lend themselves to quantitative metrics?

What about Qualitative Studies?

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TraceLab & Benchmarks

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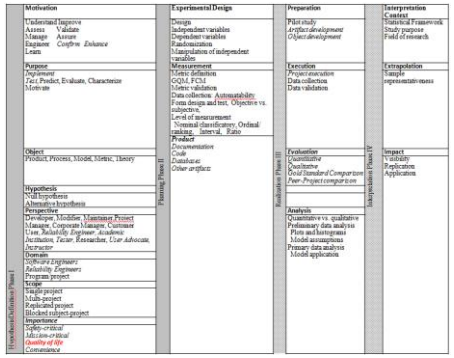


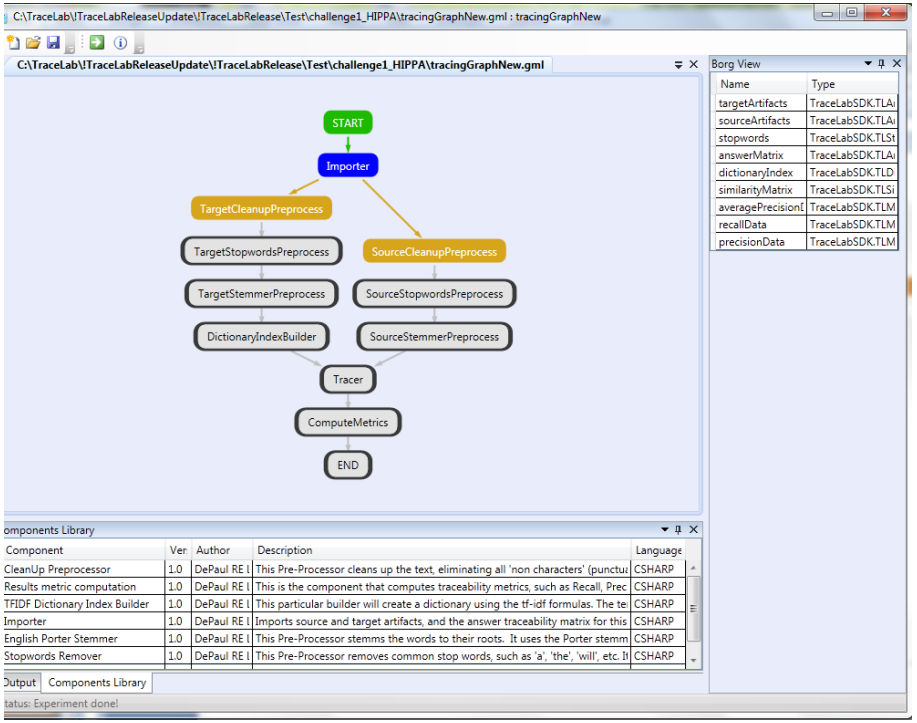
A framework enables us to collect metadata on each project, and then as a community move towards answering higher-level questions such as "under what conditions does technique X work most effectively?"

TraceLab- The Vision

- Build a tool, similar to MatLab, but designed specifically for the traceability community
- Equip new researchers with basic algorithms and components
- Make it easier to perform rigorous comparative evaluations
  - Datasets
  - Benchmarks
  - Repeatable experiments
- Permit practitioners to use "best" algorithms for specific benchmark

Major Research Instrumentation

- Currently has capabilities to design and run experiments
- Next features will integrate with benchmarking



TraceLab Version 0.1
TraceLab developers: Ed Keenan, Adam Czauderna, and Greg Leach

Traceability Research Timeline

1995 & earlier Seminal work in trace-ability

Rudimentary tools

2nd Generation of Trace features in RM tools

Technology transfer pilots

1995-2010
Numerous researchers work on various traceability topics receiving funding from NASA, NSF, & Industry

funded by NASA & NSF 2006/7

Grand Challenge Workshops held, GCT 1.0 released

2010: MRI funded by NSF for $2M

GCT 2.0 released, Jan. 2011

What next?

The Grand Challenges provide a roadmap for future research efforts and the mechanism for tracking progress towards our goals

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Backup

What is a grand challenge?

What makes this a good Grand Challenge?

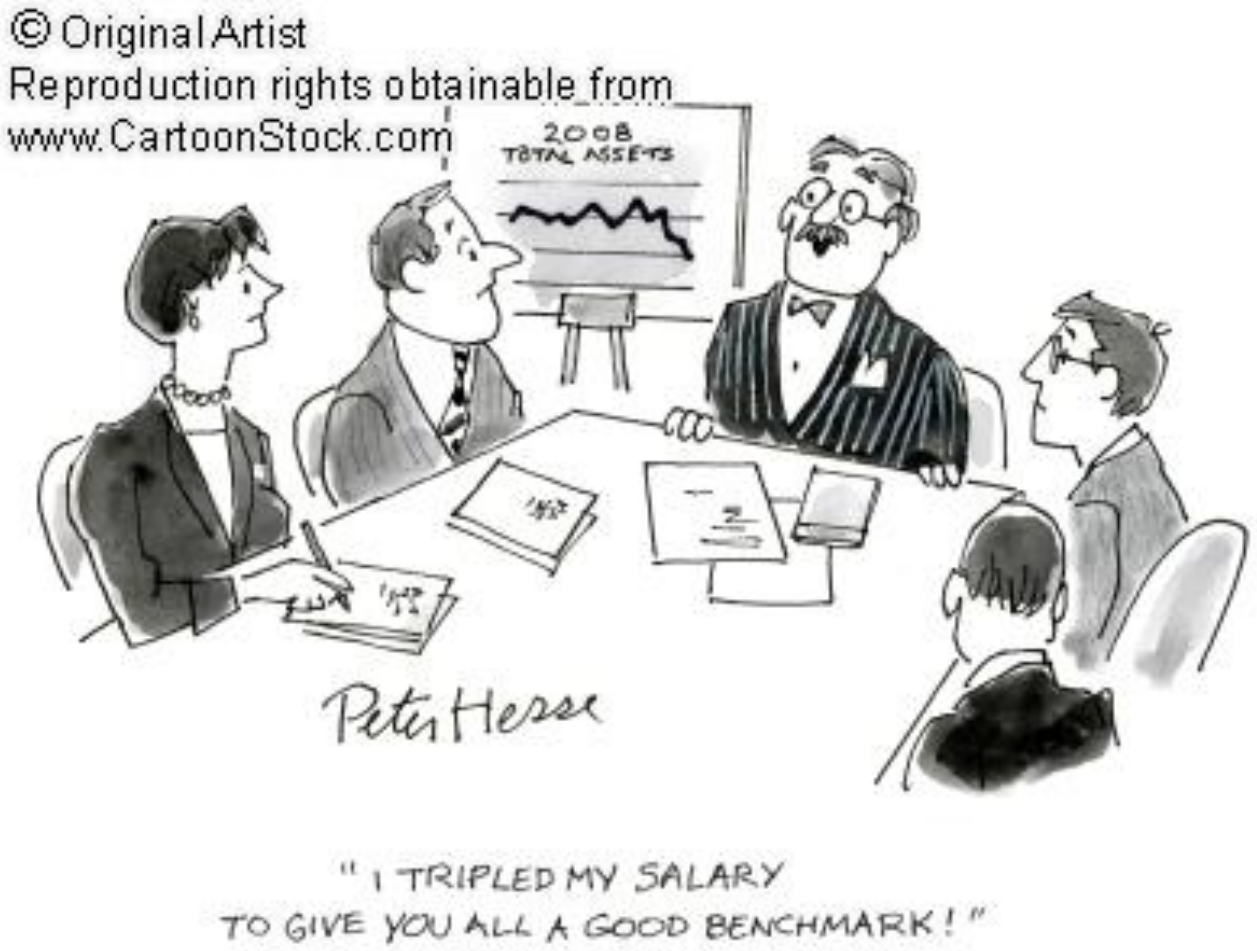
Is “Traceability” a grand challenge?

- Is traceability **important**? Why?
- Is traceability **difficult** to achieve?
- Do we have a **clear vision** of where we want to go?

Benchmarks

Recall vs. Precision problem – small changes in thresholds can have inordinate impact upon recall vs. precision – creating zigzag graphs. For benchmarking metrics, how do we overcome this?

Benchmarks



High water marks–

Will high benchmarks thwart innovation?

Is this a good or bad thing?

Benchmarks

Trust –
What kinds of checks and balances do we need to put into the process to make sure that benchmarks are fair?

How do we make comparisons anyway?

Benchmark issues

Early work

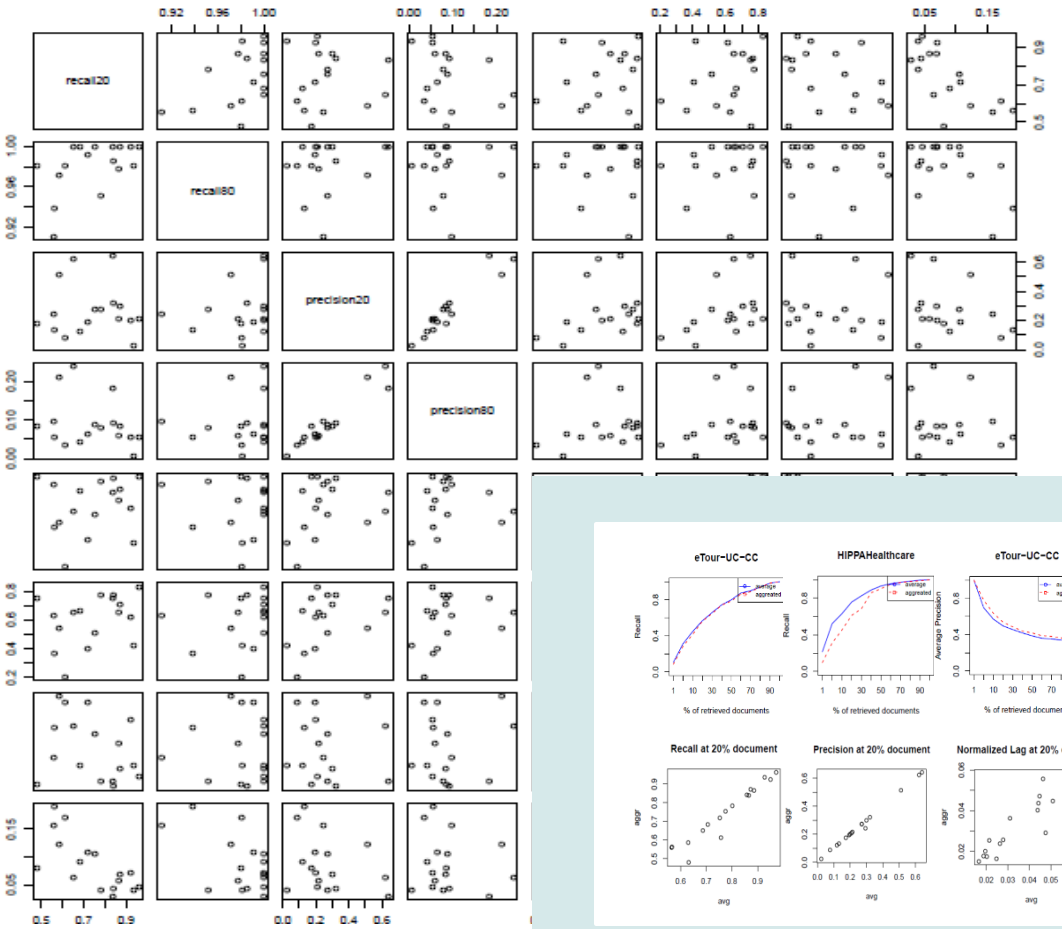
TEFSE community.

An idea.

Towards a grand challenge.

Beyond the challenges

TraceLab & Benchmarks



Yonghee's work

Benchmark insights

- What is the purpose of benchmarking our community?
  - What do we hope to accomplish from benchmarking?
- What are the major pitfalls of benchmarking in the traceability community?
  - How can we avoid them?